THE SOCIAL CHALLENGE OF GLOBAL CHANGE

A report prepared by
The Institute for Research on Public Policy
for the
Social Sciences & Humanities
Research Council

January 1990

Environment and Sustainable
Development Program
275 Slater Street, 5th Floor
Ottawa, Ontario K1P 5H9

91-04982/

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The Institute for Research on Public Policy
L'Institut de recherches politiques

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Printed in Canada

Camera-ready copy and publication management by
PDS Research Publishing Services Ltd.
P.O. Box 3296
Halifax, Nova Scotia B3J 3H7

Published by
The Institute for Research on Public Policy
L'Institut de recherches politiques
P.O. Box 3670 South
Halifax, Nova Scotia B3J 3K6

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Foreword

The report set out in the following pages advocates a substantial SSHRC program on the Social Challenge of Global Change. It suggests that about 2/3 of the funding for this new program should be directed towards individual academic research projects selected through the normal peer review process, and about 1/3 towards an enhanced process of dissemination and policy exercises to link the results of academic research directly to on-going processes of policy formation.

In elaborating this proposal, this report develops a conceptual framework which could be the basis for organizing a set of working groups to pursue applied research in this field. Within this conceptual framework, the report goes on to propose three selected themes as topics of particular interest and priority in academic research to be funded within the proposed new program.

Whether this particular structuring of topics, or this precise identification of research themes of first priority, is exactly right is probably less important than the basic message underlying the report: that there exists in Canada a capable and diverse research community in the humanities and social sciences, working on topics relevant to the most important policy challenge we currently face, which should somehow be financed more substantially and brought to bear more effectively in the formation of policy in Canada.

This report was submitted to SSHRC in November 1988. In May 1989, the Council approved a financial contribution to support its wider dissemination. Unfortunately a variety of problems has delayed the distribution originally planned for the summer of 1989. Despite the substantial passage of time since the original preparation of this text, however, and the dramatic acceleration in work on the topics it discusses, it has seemed

better not to attempt any updating of the document, but rather to leave to later reports any effort to take into account the developments of the last year. Accordingly, the report set out here is only slightly edited and corrected, with the omission of some detail now no longer relevant.

Analysis and drafting of this report was undertaken principally by Ian Jackson and Ted Parson, under the supervision of Jim MacNeill and with the advice of David Runnalls. Responsibility for any remaining omissions or flaws rests with me.

Rod Dobell
January 1990

Executive Summary

This report to the Social Sciences and Humanities Research Council (SSHRC) provides a framework for a five-year program of research, analysis and policy development on the critical issues of global change and sustainable development. It proposes that Canada's capacity for human sciences research on global issues should be greatly strengthened, with a significant increase in funding through SSHRC and other means. It also proposes use of a new style of research aimed at meeting a growing and urgent demand for informed policy on global change issues.

This proposal on the Social Challenge of Global Change has been developed by the Institute for Research on Public Policy (IRPP), in cooperation with the Royal Society of Canada (RSC). Preparation of the proposal has been supported by SSHRC, as part of the Council's 'one time experimental program designed to help identify priority areas for research and to explore ways of enhancing the national contribution of the social sciences and humanities.'[1]

The program has been conceived within a broad international context, marked by exploding demands for information, policy development, and action, and a growing need to understand and, where possible, influence the phenomena of global change. The program is based on the view that 'research on topics of national importance', research that is linked to 'the challenges faced by contemporary society',[2] should be conceived both to advance knowledge and to suggest solutions. Such research can be expected to address the illnesses of, or threats to, Canadian and global society, in the same way that research into medical problems frequently both advances knowledge and has important clinical implications. The proposal recognizes that research reports by themselves seldom lead directly to policy and action. It therefore includes elements that, even if they go beyond

the present funding limitations faced by SSHRC, strongly support the Council's objective to 'enhance the national contribution of the social sciences and humanities.'

The need for recognition of the Social Challenge of Global Change as a strategic theme for Canadian research arises from two important streams of intellectual development that have converged in the last few years. First, natural scientists have reached general agreement that changes of unprecedented magnitude are taking place in the atmosphere, the oceans, and terrestrial ecosystems. They have concluded that novel forms of collaboration between physical and biological scientists are needed to understand these changes. The International Geosphere-Biosphere Programme (IGBP) will be the principal international effort in this direction during the 1990s. The Royal Society of Canada is organizing and leading Canada's contribution to IGBP, through its project on Global Change.[3] A similar international program in the social sciences and humanities, under the title Human Dimensions of Global Change,[4] is being developed in parallel with IGBP, and the present proposal has been conceived as the principal Canadian contribution to the Human Dimensions program.

Second, a long line of political and social thought has asserted that both the causes and consequences of global change can be understood only by examining human attitudes, values and behaviour, and by illuminating the processes through which our public and private institutions arrive at decisions on economic and social development. *Our Common Future*, the Report of the World Commission on Environment and Development (the Brundtland Commission) is the most recent landmark demonstration of this need.[5] The Report identified behaviour patterns, public policies and modes of decision making that are now driving the destruction of the planet's environmental resource base, reducing the potential for development, and threatening survival. It proposed profound changes in these in order to effect a transition to sustainable development.

One example of such changes – described by the Brundtland Commission as 'the chief institutional challenge of the 1990s' – is that

> the ecological dimensions of policy be considered at the same time as the economic, trade, energy, agricultural, industrial, and other dimensions – on the same agendas and in the same national and international institutions . . .
>
> . . . the major central economic and sectoral agencies of governments should now be made directly responsible and fully accountable for ensuring that their policies, programmes, and budgets support development that is ecologically as well as economically sustainable.[6]

The analysis and recommendations of the Brundtland Commission have been widely endorsed by leaders of government, industry, institutes and academe, nationally and internationally. The National Task Force on Environment and Economy adapted the Brundtland recommendation to Canada.[7] Its report has been endorsed by First Ministers, and includes a call for greatly increased research on the socio-economic and institutional dimensions of the issues. Similar processes are underway in other countries, and in a large number of international organizations. The 1988 G7 Economic Summit in Toronto

addressed global change issues, and endorsed the principle of sustainable development in its final communique.

As a consequence of the attention and support that issues of global change and sustainable development have attracted, there now exists an unprecedented demand for advice on the behaviourial, policy, and institutional changes needed to address the issues, or to adapt to the realities, of global change. This demand far exceeds the existing capacity for research, analysis, and policy development by those individuals and institutions now engaged in such work.

Of the vast relevant world literature (surveyed in an Appendix), only a relatively small part is *explicitly* on global change; that which is tends to be removed from the academic mainstream. A greater body of research is *implicitly* relevant to global change. Although not motivated by considerations of sustainability, it is related to three broad themes: the social origins of global change; the social impact of global change; and the social response to global change. Much of the material in the last category is descriptive, but some is prescriptive, and presumes the ability of societies to manage change.

This proposed five-year program of research, analysis, and policy development is driven essentially by policy concerns, and focuses on providing analysis and information in forms that policy makers can use. It therefore takes into account the SSHRC's expressed wish to 'play a more active and central role in addressing the challenges faced by contemporary society' and to emphasize 'the usefulness of social sciences and humanities research in Canada.'

Even when undertaken by multidisciplinary teams, academic and similar research is seldom planned with the needs of the potential users in mind; with questions framed in terms meaningful to them; and with the results prepared and packaged in ways that they can understand and use with confidence. Along with the highly selective research program, therefore, IRPP proposes a much broader dissemination effort, involving a high-level panel or advisory committee as an integral part of the link from the research effort to the policy applications. This panel would include leaders from the research community, together with senior policy makers in government and the private sector, and other appropriate individuals and representatives.

The panel would also provide guidance for a process of applied policy analysis, to be managed by IRPP in cooperation with the RSC, employing various techniques. In particular, these would include 'policy exercises' around selected priority issues where there is both a need and a demand for policy advice. IRPP's policy exercises would provide an interface between academics and policy makers, with a policy analyst and support staff provided by IRPP. They would bring together, for a period of several days to a week, policy and decision-makers, the natural and human scientists doing research in academe or institutes on various aspects of the issue, and other experts, for example in systems analysis. The exercises would be structured flexibly, and would serve to synthesize and assess knowledge accumulated in several relevant fields for policy purposes, in light of real institutional and political problems. The participants would be expected to consider the real constraints to resolution of a policy issue, how best to formulate the questions requiring analysis, how to achieve solutions to broad issues that are decided as much by

societal consensus – or the lack of it – as by systematic analysis, and how to package and present the results to users.

As regards the costs of the program, the Institute recommends that SSHRC provide $525,000 in the first year of the program and $1.2 million in the second and subsequent years. A strategy is proposed, based on SSHRC's concept of a 'concerted initiative', that anticipates a total annual flow of funds into research on this strategic theme of over $2,000,000.

The conceptual framework adopted in the proposal, in advocating research to inform policy, presumes that policy can make a difference. In this view, the study of causal mechanisms is considered a search for opportunities for intervention, where intervention is found to be essential. Some elements of human response to global environmental change are no doubt subject to conscious intervention, and others are not. Similarly, collective action to intervene in social and economic adjustment mechanisms may be appropriate in some situations and not in others; the identification of situations where intervention is called for is a necessary theme in the research plan.

If we accept this policy-oriented framework for research on the Social Challenge of Global Change, it becomes possible to identify several criteria to govern the selection of topics and the determination of priorities. These criteria include:

- that the research topic offer a reasonable expectation of yielding knowledge useful to policy-makers;
- that the research focus on the phenomena that link the social, economic and cultural causes of global change back to the perceived impacts of global change;
- that it be consistent with the efficient allocation of research effort internationally, by focusing on particular Canadian research needs, opportunities, or advantages.

Three principal themes are proposed for the five-year research program: Institutions and Decision Processes; Economy-Environment Linkages; and the Cultural and Ethical Roots of Economic/Environmental Behaviour.

In the first of these themes, it is recognized that whereas our economic and ecological systems have become totally interlocked in the real world, the relevant institutions remain almost totally divorced. If society is to gain greater capacity to manage the human dimensions of global change, it must find ways to bridge this gap, and to integrate ecological considerations into central political and economic decisions.

The dangers posed by global change, and the need for alternative, sustainable, forms of development must become primary considerations in decisions on macroeconomic policy, trade and fiscal policy, science and technology, energy, agricultural, industrial and other sectoral policies. This imperative calls into question current forms of responsibility and accountability in public and private institutions; it also raises major questions about the shape and political feasibility of alternative forms that are to be incorporated in actual institutional structures and decision-making processes.

In regard to the theme of Economy-Environment Linkage, the academic literature on this topic is well developed at a theoretical level, but corresponding empirical work is largely lacking, and the broad appreciation necessary for practical application in government or corporate decision processes is almost entirely absent. There can be no doubt that, if societies in Canada and throughout the world are to respond effectively to the threats posed by accelerating global change, major alterations will be required to long-standing and well-established policies and practices that are at the heart of the linkage between economy and environment.

Policy-oriented research on the relationship between structural change in the economy and global change is also vital. It can be demonstrated fairly readily that a reduction in the resource input of production will usually lead to a reduction in the amount of emissions and wastes, as well as to a reduction in the overall costs of production, and consequent increase in productivity and competitiveness.

Ethical and Value Systems are at the root of much of the human behaviour that contributes to global change. It has been argued that an essential requirement for a realistic study of the social dimensions of global change should be '. . . a realistic appraisal of the breadth of interests of human beings, of their passions, of their capacity for rational choice, and of their capacity for perverse or counter-intuitive behaviour.' Similarly it has been suggested that 'The somewhat mechanistic manner in which the broad [global change] issues have been cast by many hurried experts might explain why they have failed to ignite any real interest in the population . . . In many ways, the lack of a satisfactory model of man may lie at the root of the apparent incapacity to mobilize the population on the subject of global change.'

I. Global Change

A. The Challenge to the Human Sciences

Global Change is as concerned with human behaviour as it is with the future of the planet. As expressed in the submission by the Royal Society of Canada to the Natural Sciences and Engineering Research Council,

> Modern scientific observations of the global earth system, both from orbiting space platforms and from conventional earth bound stations, have clearly established that the planet is under extreme stress and that the stress is man induced. Humankind has become a principal agent of change in the planetary environment and most often the changes that we cause are for the worse.[8]

Human-induced stress on the natural environment is not new. Such stresses appear to have been at the root of the decline of earlier societies, cities and civilizations, but they have become much more diverse, large-scale, and pervasive, and marked by multiple interactions and connections. It has become increasingly obvious during the 1970s and 1980s that human activity now threatens the stability of the global ecosystem on which human culture, society and economy are ultimately based. As the World Commission on Environment and Development (the Brundtland Commission) observed in the opening chapter of its report, *Our Common Future*,

> Today the scale of our interventions in nature is increasing and the physical effects of our decisions spill across national frontiers. The growth in economic interaction between nations amplifies the wider consequences of national decisions. Economics and ecology bind us in ever-tightening networks. Today, many regions face risks of irreversible damage to the human environment that threaten the basis for human progress.[9]

The Commission saw 'these deepening interconnections' as the main *raison d'être* for its mandate; they are also the principal reason why the social sciences and humanities should be at the centre of international programs to investigate global change and its implications for the future of humanity.

The scale of human activities is now so great that the economy and the environment are in fact inextricably linked – component parts of one integrated dynamic system. But human activities are driven by habits, values, beliefs, and discretion, not by natural law. The challenge now is to integrate our concerns for environmental and economic goals within individual perceptions and social decisions. Integration in fact at the level of consequences demands integration in principle at the level of discretion.

The list of human activities that induce global environmental stress has become widely known in recent years. Apart from population (which is expected to double again in the next three to four decades), and urban growth, the list includes energy development (fossil fuel use has grown 30-fold since 1900); the production of toxic chemicals (up to 2000 new chemicals are added to the economy and to the environment each year); the use of products that interact with the physical or biological environment (e.g. chlorofluorocarbons or CFCs, which have caused the ozone layer over Toronto to diminish by 3.0 per cent to date); intensive agriculture (more land has been cleared for settlement and agriculture in the past century than throughout the whole of earlier history, and water use has doubled twice since 1900 and is expected to double again before 2000).[10]

These activities have resulted in a massive draw-down of the Earth's basic ecological capital, as evidenced by widespread deforestation (an area the size of the United Kingdom each year); erosion and desertification (an area the size of Africa is threatened); species loss (about 50 a day and climbing); and now the 'greenhouse effect', with global warming and sea-level rise. This continuing draw-down of basic capital is not sustainable. It calls into question our survival both as a world community of nations and as a species. Yet, if the needs and aspirations of growing populations are to be met, economic activity will have to increase 5- to 10-fold in the next four or five decades.[11]

Two conclusions seem inevitable. First, few problems can be solved by tackling a single cause. Most have multiple causes. Much of the increase in greenhouse gases, for example, is due to the release of carbon dioxide through the burning of fossil fuels, but widespread deforestation could account for over 25 per cent of the increasing carbon load on the atmosphere. Soil erosion and loss of fertility are also related to deforestation, as well as to inappropriate agricultural patterns (which may themselves be caused by population pressure).

Secondly, reversing the decline in environmental capital will often require changes in individual and collective human behaviour that have profound implications for social, economic and cultural patterns. Reduction in the use of fossil fuels to limit global warming is a case in point. The roots of environmental stress lie deep in human philosophies, policies and patterns of behaviour. A transition to sustainable development will require revolutions in human behaviour that must be accomplished rapidly and voluntarily, if the change is not to be forced by catastrophe.

In face of the unprecedented changes that are taking place in the atmosphere, the oceans, and terrestrial systems, the scientific community has agreed that novel forms of collaboration between physical and biological scientists are needed to understand them. They are coming together in a coordinated global research program, throughout the 1990s, known as the International Geosphere-Biosphere Programme (IGBP). The Royal Society of Canada is organizing and leading Canada's contribution to IGBP through its project on Global Change.

The IGBP is mandated to look at the extent to which global change is influenced by human actions. Current planning, however, indicates that IGBP will stop short of examining the sources of global change in socio-economic and other human activities, or the socio-economic, political and ethical responses to global change. Nor will the program in the natural sciences examine the problems of collective action and institutional structure that constrain public policy in this field. Instead, IGBP will seek to understand the stresses on natural systems caused both by natural forces and by human activities; the probable consequences if these stresses are maintained; and the qualitative and quantitative changes that are needed if the planet is to regain its lost environmental stability.

Meanwhile, there is an exploding demand for policy relevant research, as the consequences for humanity of global change become apparent. Already, governments have moved to limit the use of the chlorofluorocarbons (CFCs) that are destroying stratospheric ozone; other recent developments include:

- President Gorbachev's call for an international conference 'to devise a global strategy' for global change;
- Similar calls for high-level international discussions on global change by both U.S. presidential candidates;
- inclusion of global change and sustainable development on the agendas of many governments, the United Nations system, Commonwealth Prime Ministers, other intergovernmental bodies such as OECD, ASEAN and OAU, and the World Bank and several regional banks;
- endorsement of the concept of sustainable development by the G7 Economic Summit in 1988, and its inclusion on the agenda for the 1989 Summit.

Issues of global change and sustainable development are probably on summit agendas to stay. Climate change alone may assure this. Global warming of up to 4.5°C., and a sea-level rise of up to 1.5m., may be only 10 elections away, at four-year average intervals. If the current broad scientific consensus is correct, the consequences of global warming could become clearly evident to every citizen of the world within another one or two election cycles.

With such considerations in mind, an international program of research in the human sciences is being developed under the title of the Human Dimensions of Global Change (HDGC), 'to investigate both the human causes and consequences of global environmental change.'[12] The international sponsors of this program are the Inter-

national Federation of Institutes of Advanced Study (IFIAS), the International Social Science Council (ISSC), and the United Nations University (UNU). HDGC is conceived as separate from but closely linked to the International Geosphere-Biosphere Program in the natural sciences. In Canada these links will be particularly close, since the Royal Society of Canada, which is responsible for Canada's contribution to IGBP, has always seen the necessity for a parallel and coordinated research initiative on global change by the human sciences. A preliminary survey of the Canadian role in such an international program took place at the 1987 annual meeting of the Society, with SSHRC support.[13]

Two further distinctive characteristics of this proposal on the Social Challenge of Global Change are important. Firstly, the issues involved are such that integrative and cross-disciplinary approaches will be required in most major initiatives. Implicit or explicit in much human sciences research is the so-called EERE assumption ('everything else remains equal'). So pervasive and widespread are the probable impacts of global change, however, that research on a specific aspect or impact of change cannot credibly assume that everything else will remain equal. As a simple example, a study of the impact of climate change on agriculture in Ontario cannot limit itself to the gains or losses in yield or return due to changing temperature and precipitation in the area. Since the climate everywhere can be expected to reflect the impact of greenhouse gases, the future of Ontario agriculture must be evaluated in the context of the future crop and market situations throughout North America, and perhaps globally. Studies of the human dimensions of global change that rest on untested assumptions about other areas or other disciplines will be of doubtful value.

It can be argued, in fact, that scientific modes of research based on reductionism are inherently inappropriate for global change, since reductionism inevitably tends to imply EERE. Instead, it may be necessary to begin at the global, the general, and the multidisciplinary levels, moving to the study of specific situations only when there is general agreement on the broad character of change.[14]

The second distinctive characteristic of the research that is required is that, if it is to be effective in influencing national and international policy and action, it must be conceived within an overall framework of policy development. This aspect is elaborated in more detail in Chapter II.

B. The Existing Knowledge and Research Base

The bibliographic survey undertaken as part of the present project demonstrated that the relevant world literature is vast, and that it includes a strong Canadian contribution (Appendix). Only a relatively small part of the relevant social science literature, however, is *explicitly* on global change; that which is tends to be removed from the academic mainstream. A greater body of research is *implicitly* relevant to global change. Although not motivated by considerations of sustainability, it is related to three broad themes: the social origins of global change; the social impact of global change; and the

social response to global change. Much of the material in the last category is descriptive, but some is prescriptive, and presumes the ability of societies to manage change.

Although the IGBP will exclude consideration of the human values and attitudes behind the causes of global change, focusing instead on natural change and the impact of human activities on physical and biological systems, several projects that pursue the human component are being developed internationally, especially in the United States. The literature survey suggests that their evolving agendas are marked by a number of common elements: e.g. institutions; demography and land use; values and culture; technology; and coordinated data collection.

Some research is currently under way in Canada on a few themes relevant to global change issues: e.g., defining sustainability; regional studies; policy exercises and gaming; adaptation, resilience, and surprise; environmental ethics; environmental history; culture and values; and institutional models for sustainable resource management. The survey indicates, however, that this research is limited in scope, and is centred in only a relatively few institutions.

Canadians, though relatively few in number, are stewards of a large part of the planet, and the way that we manage our part of the world has great significance for global change. There is substantial potential in Canada for research relevant to policies on global change and sustainable development. In most fields, the number of key researchers and institutions should be augmented and strengthened. At present, however, the financial resources needed to support such research are lacking.

II. Proposal

A. Policy Research: Providing Useable Knowledge

This proposed five-year program of research, analysis, and policy development on the critical issues of global change and sustainable development provides the opportunity for SSHRC to respond to the need and challenge described in Chapter I. The program is driven essentially by policy concerns, and focuses on providing analysis and information in forms that policy makers can use. To this end, it provides for a new style of research, with mechanisms through which leaders from government, industry, institutes and academe will be involved together in a continuing process to review the goals of the program, to identify priority issues for consideration and the research needed to fill knowledge gaps, and to provide early warning of the issues that will need attention in the future.

The emphasis of this proposal is on usable knowledge, on an effective link between disciplinary perspectives and a policy agenda. Such a link demands a focus on the underlying causes of the human behaviours which compromise the integrity of the Earth's natural systems, and hence jeopardize the future not just of economic systems but of society itself. Concern with the proximate manifestations of environmental damage is fine as far as it goes, but the basic issue is one of social learning: of effective entry for new knowledge into processes of change.

There is no question in this election year that a growing political consciousness is being translated into growing political pressures for action on environmental concerns, and is generating a growing political response (at the level of declaration, rhetoric and consultation at least). But bringing this general consciousness to bear on the individual

decisions which determine our future will demand signalling mechanisms that we do not yet have in our social systems.

In particular we operate socially with a very selective, highly distorted information system. Partial information on financial impacts and concerns is readily available to business and government; more comprehensive information on fundamental concerns relating to human and natural resources or environmental consequences of current action is almost universally lacking. We are forced to work, in economic activity as well as social policy, with perverse indicators of economic and social performance.

What is proposed in this report is a process to bring a synthesis of relevant results of academic or independent research – even when admittedly incomplete, controversial, or subject to dispute – into a form useful to those who are condemned to take or advise on decisions, in the face of profound uncertainty, before all the evidence is in. Such materials must be practical and holistic in nature; the Cartesian approach which serves analysis well by breaking hard problems into manageable intellectual pieces cannot serve social decision processes adequately.

B. Structure for a Program of Policy Research

In order to respond quickly and effectively to the policy research needs outlined in the preceding chapter, we set out in this section a proposal for the organisation and funding of a program of applied research and, more particularly, its dissemination and application within corporate and governmental processes of policy formation. This chapter therefore addresses the question of overall organization, the role and contribution that IRPP might offer, the particular device of 'policy workshops', and possible funding mechanisms. In particular, by setting out what we believe to be a feasible and promising scheme for matching funding mechanisms, we are offering, by example, a positive evaluation of funding mechanisms of the type that IRPP was asked by SSHRC to evaluate. The substantive research needs are discussed in the following chapter.

As an institute concerned with public policy research, IRPP recognizes that the human dimensions of global change are likely to have major policy implications for Canada that will affect every Canadian, directly or indirectly. Something similar, to a greater or lesser extent, can of course be claimed for each of the strategic themes already supported by SSHRC: that is why they were so designated. Global change, however, has so many diverse policy implications, the nature of which are only dimly beginning to be perceived by governments and the public, that something more seems required than the familiar system of research grants and subsequent scholarly publication of research findings.

If the aim is to influence public policy, a broadly-based and pro-active framework is required, one that through various mechanisms seeks to make the issues of global change understood and appreciated by government agencies, academe, industry, interest groups, political leaders and the general public. Apart from involving such groups in the research

process (e.g. through seeking their views and encouraging their input and concern), this process will help to create an intellectual and political climate that is ready to receive the results of the policy research when these become available, and to speed the transition from research results to policy development and action.

In very simplified form, the policy development process can be seen as proceeding from a review of the present state of knowledge to the identification of research needs to the actual research itself. Once the research has been completed there is a need to determine its policy implications, develop policy options and formulate policy proposals.

This process clearly embeds research – the main focus of SSHRC's activities – in an overall process that, in the Council's words, would support 'studies which could contribute to the development of public policy on national priorities'.[15] The Council has recognized that both the earlier and later stages in this process have tended to be neglected in the past: 'No real input from government and Canadian society has been incorporated either in the selection of strategic areas for research or in the monitoring or the evaluation of the results from such work.'[16]

Even when undertaken by multidisciplinary teams, research by university professors and academic institutes is seldom planned with the needs of the potential users in mind; with questions framed in terms meaningful to them; and with the results prepared and packaged in ways that they can understand and use with confidence. If the Social Challenge of Global Change program is to be effective, a key requirement, in IRPP's opinion, will be the establishment of a process that effectively links underlying academic research to ongoing policy debate. To encourage promising lines of applied research; to identify results relevant to policy concerns; to synthesise these in a graphic manner; and to bring them to bear directly and in a timely fashion on particular policy concerns in an appropriate institutional setting: these are tasks that go beyond the usual research dissemination efforts. Along with the highly selective research program, therefore, IRPP proposes a much broader dissemination effort, involving a high-level panel or advisory committee as an integral part of the link from the research effort to the policy applications. This panel would include leaders from the research community, together with senior policy makers in government and the private sector, and other appropriate individuals and representatives. Such a group would not threaten the independence or the integrity of the research in any way, but the presence of such a panel would indicate the importance of the work that was being undertaken, and the members of the panel would be influential in ensuring that research findings were acted on and not ignored.

Without in any way inhibiting the normal process of peer review and publication, the panel would also provide guidance for a process of applied policy analysis, to be managed by IRPP in cooperation with the RSC, employing various techniques. In particular, these would include 'policy exercises' around selected priority issues where there is both a need and a demand for policy advice.[17] In Canada alone, potential users include federal and provincial governments, corporate bodies and the newly-established national and provincial Round Tables on Environment and Economy. Internationally

this strategic theme would be highly relevant to Canada's role in the 1990 World Climate Conference and the 1992 World Conference on Sustainable Development.

IRPP's policy exercises would provide an interface between academics and policy makers, with a policy analyst and support staff provided by IRPP. They would bring together, for a period of several days to a week, policy and decision-makers, the natural and human scientists doing research in academe or institutes on various aspects of the issue, and other experts, for example in systems analysis. The exercises would be structured flexibly, and would serve to synthesize and assess knowledge accumulated in several relevant fields for policy purposes, in light of real institutional and political problems. The participants would be expected to consider the real constraints to resolution of a policy issue, how best to formulate the questions requiring analysis, how to achieve solutions to broad issues that are decided as much by societal consensus – or the lack of it – as by systematic analysis, and how to package and present the results to users.

The participants selected for a policy exercise would depend on the issue, but care would be needed to ensure the participation of leading experts from all disciplines of critical importance to the issue, as well as influential stakeholders and senior decisionmakers faced with actual policy choices. Over time, these exercises could serve both to increase the relevance of research, and to inform and improve the real policy process in government, industry and the proposed Round Tables. They would also permit SSHRC itself, if the Council wished, to become more actively involved in establishing priorities for a coordinated research program, and to act with government departments and agencies as co-funders to stimulate selected research activities in critical applications areas.

The core of this proposal, therefore, is the synthesis of the results of the research and networking activities, and their development and application in a variety of interactive, consultative and policy formation processes at provincial, national, and international levels. These processes of dissemination and animation, designed to achieve application of research work in policy settings, will involve IRPP's staff, participants in workshops and policy exercises, IRPP's Council, the high-level panel, and – to the extent it deems appropriate – SSHRC itself, as well as the Royal Society of Canada and participants in its Global Change activities. Their results in turn will contribute both directly and indirectly to the discussions of consultative and decision-making bodies charged with effective integration of economic and environmental considerations.

SSHRC is already committed 'to promote excellence in assisting research and scholarship . . . through [*inter alia*] the funding of infrastructural and communication facilities or services for the improved production and dissemination of new knowledge'. When this role is linked to a strategic thrust on the Social Challenge of Global Change, what is envisaged is a joint venture involving SSHRC, IRPP, RSC and a number of other governmental and nongovernmental bodies. As such, it would be exactly what was envisaged as a 'Concerted Initiative' in the Interim Report of the SSHRC Task Force on Priorities (January 1988).

III. Conceptual Framework and Research Themes

A. A Conceptual Framework for Global Change Research in the Social Sciences and Humanities

1. Purposes of a Conceptual Framework

There are two things we want from a conceptual framework: that it provide an organizing scheme to help clarify our thinking on the exceedingly broad subject-areas bearing on global change; and that it help us find criteria to define a coherent set of research themes that are most suitable for a 5-year Canadian program. This chapter approaches the two questions in order: first attempting to clarify the structure of research opportunities, then drawing out promising themes.

2. Causes, Impacts, and Responses

A possible, and popular, conceptual approach to the problem is to divide social aspects of global change into three parts: social causes of global change, social impacts of global change, and social response to global change. Studying the social causes involves investigating what human activities are the principal sources of significant environmental change. In some instances, these questions are easy to answer; an example is the origin of increased atmospheric CO_2 in increased fossil fuel combustion and tropical deforestation. In other cases, finding the human sources of environmental changes may be very difficult; human-related sources of increased atmospheric methane are a clear example.

Before undertaking the exercise of analysis – breaking the hard problems down into its parts, in the manner advocated by Descartes – it is useful to remind ourselves that all our activity is embedded in some all-embracing ecosphere (or noosphere) or GAIA. Figure 1 emphasizes this perspective, showing the economic mechanisms which so dominate contemporary debate as only one set of social constructs among many we may elect to organize our social relationships, and indeed representing all human activity as but one part of the vast interactive natural system within which we live. In this view, the environment is our home; the economy is but one set of structures regulating part of what we do there.

Studying social impacts involves asking what environmental changes are most important for societies, and how to measure their effects. The social response is the linkage between sources and effects on the human side. What economic, institutional, and cultural factors determine the activities and artifacts that represent the crucial human burdens on the global system and determine the nature and extent of impact? What are the linkages through which impacts on society influence social causes? How do these linkages evolve, and how can they be influenced?

Figure 2 illustrates this threefold division of the issue. The social and natural (biogeochemical) systems are shown as separate systems, interacting through social causes of global environmental change on the right, and social impacts on the left. The human response is shown as a set of complex interactions internal to the social system that connects social impacts to social causes.

Simple though Figure 2 is, it still embodies the fundamental change of view that has appeared over the past 30 years – that economic (and other human) activity is an open subsystem of a closed system; the larger closed system, the environment, provides the context for human activity.[18] The dominant earlier view would have shown the social system without connections to a natural system, or at least without connection to a natural system whose internal dynamics mattered. Instead, economic activity was treated as the drawing of natural resources as material inputs from an infinite source, and the dumping of waste products into an infinite sink. To close the loops is to admit the possibility of limits on the material scale of human activity, to recognize that human impacts on the natural systems may alter the range of possible actions available to humans. This view tends to emphasize feedbacks involving renewable resource systems, rates of change, and time-scales, rather than the hard limits associated with the exhaustion of non-renewable resources that were emphasized in the early 'limits to growth' literature.

There are two broad philosophical approaches to this study. A large body of work in the social sciences proceeds from the assumption that the dynamics and feedbacks determining human choice and response are deterministic. This perspective can be found in Marxist theories of history, in behaviourism, and, with respect to policy interventions, in the modern economic doctrine of rational expectations. From the perspective of policy responses to global environmental change, none of these views offers any hope of making any difference.

Figure 1

GAIA

Human Activity Embedded in the Natural World

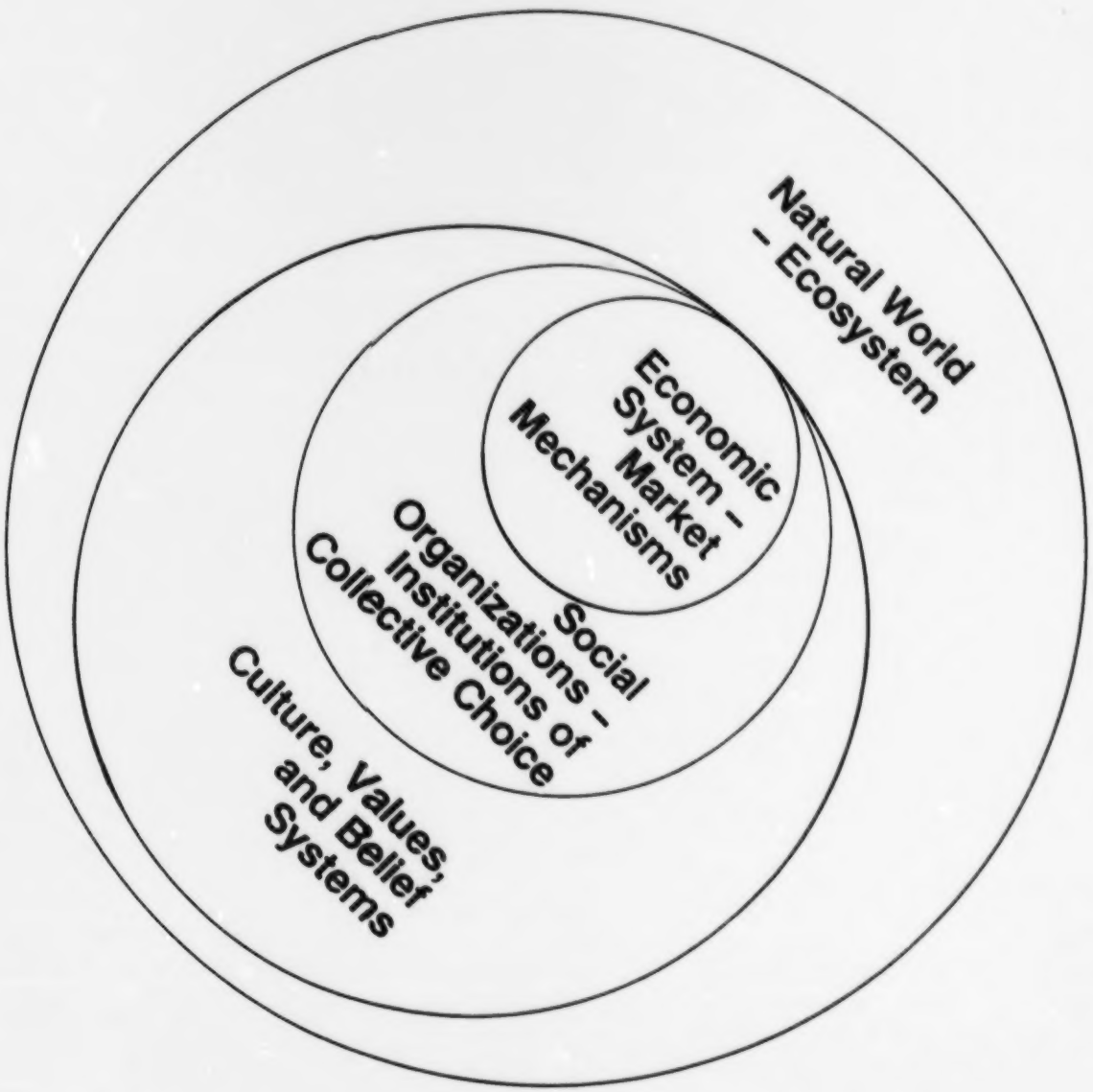
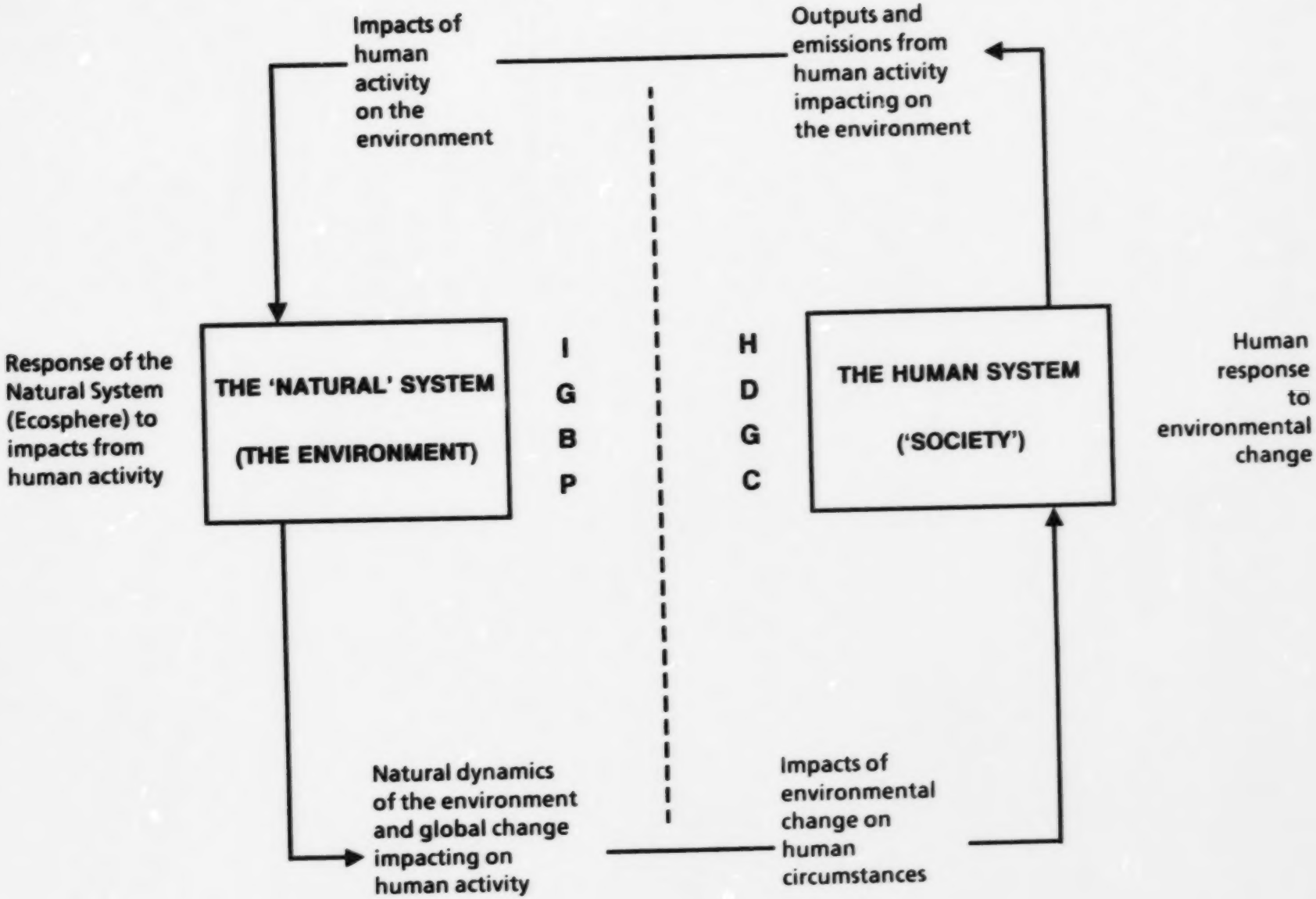


Figure 2


Impacts of human activity on the environment
Outputs and emissions from human activity impacting on the environment
Response of the Natural System (Ecosphere) to impacts from human activity
THE 'NATURAL' SYSTEM
(THE ENVIRONMENT)
I
G
B
P
H
D
G
C
THE HUMAN SYSTEM
('SOCIETY')
Human response to environmental change
Natural dynamics of the environment and global change impacting on human activity
Impacts of environmental change on human circumstances

We adopt the alternative view; in advocating research to inform policy, we presume that policy can make a difference. In this view, the study of causal mechanisms is considered a search for opportunities for intervention, where intervention is found to be essential. This view imputes only weak causality to human systems, akin not to natural law but to habit. Deterministic social theories cannot be rejected out of hand, though; they remind those who advocate policy interventions of the need for humility. Some elements of human response to global environmental change are no doubt subject to conscious intervention, and others are not. Similarly, in some cases collective action to intervene in social and economic adjustment mechanisms may be appropriate, and in other cases action may be inappropriate; the identification of situations where intervention is called for is indeed one theme in the research plan outlined below.

The need for humility is particularly evident when comparing the limited repertoire of policies available at the national level to the variety of scales at which human response can occur. Since we are principally concerned with national policy needs, we must look for opportunities where policy at the national level can exert its maximum influence, while recognizing that some aspects of human response will be outside anyone's control and that others, controllable at family or community scale, or even at international scale, will not be controllable at national scale.

In summary, we are looking inside the human system, but focusing on those sectors where decisions have the strongest links to the natural system. In the Canadian context, we suggest four sectors where human activities are particularly strongly linked to the environment: Energy policy; Agriculture, Forestry, Fisheries and Wildlife policies; Air and Water Policy; and Urban and Industrial policy. In addition to being areas of greatest impact, these policy areas correspond to the responsibilities of existing federal and provincial government departments, so focusing on them is most likely to lead to questions for which policy-makers need answers.

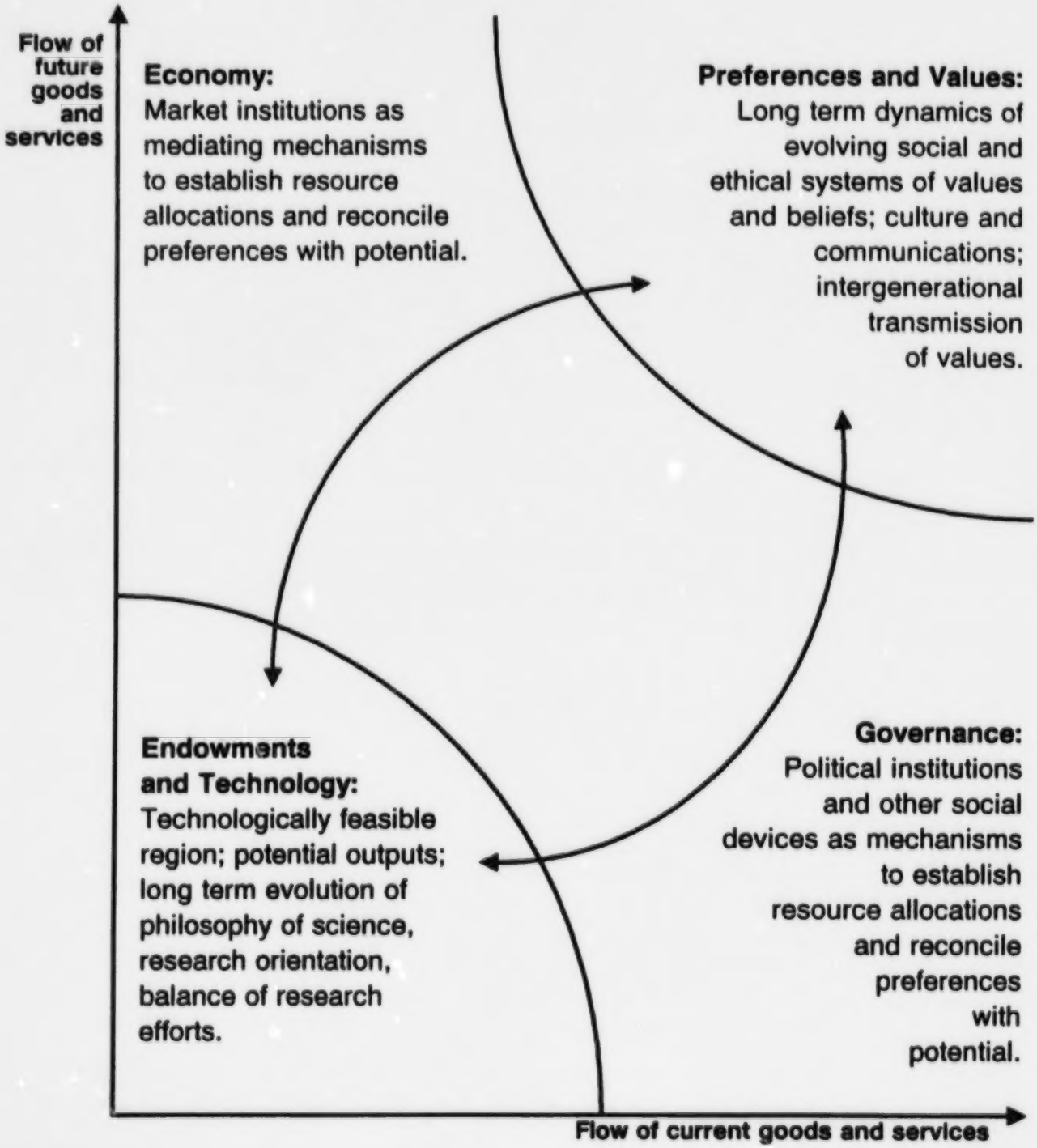
3. *A second organizing scheme: looking into the determinants of social response*

Figure 3 suggests a scheme for organizing an examination of social science research relevant to global change in general and these four policy areas in particular. It reflects a conventional and convenient decomposition of the factors or determinants underlying social choices on resource use into three categories:

> ***Technology and Endowments***, reflecting the facts of life and dictating what selections or outcomes might be technically or physically feasible; ***Culture and values***, reflecting tastes and preferences, and indicating what outcomes might be thought desirable; and ***institutions or mechanisms of collective choice*** intermediating between what is desirable and what is possible, providing a mechanism whereby individuals and communities arrive at allocations of resources satisfying preferences as

Figure 3

Internal structure of the social system: choice among competing outputs achieved through alternative allocations of resources; looking behind the economic framework to the underlying human sciences


Flow of future goods and services
Economy:
Market institutions as mediating mechanisms to establish resource allocations and reconcile preferences with potential.
Preferences and Values:
Long term dynamics of evolving social and ethical systems of values and beliefs; culture and communications; intergenerational transmission of values.
Endowments and Technology:
Technologically feasible region; potential outputs; long term evolution of philosophy of science, research orientation, balance of research efforts.
Governance:
Political institutions and other social devices as mechanisms to establish resource allocations and reconcile preferences with potential.
Flow of current goods and services

well as possible. For present purposes it is useful to separate these institutions into two distinct categories: market mechanisms (the *Economy*), and other structures for collective choice (*Institutions of Governance*).

Figure 3 thus suggests that in explanation of economic activity and resource allocation, it is helpful to think of an individual or a community as having objectives or preferences with respect to present and future outputs of goods and services (or present and future consumption), for example; as facing constraints on possible outcomes arising from existing resource endowments and states of technology; and as resolving the decision problem by some process of choice which selects from amongst the various combinations which would be technically feasible that which is optimal, or most highly desired. These processes of choice of course work for the most part routinely, in highly decentralized fashion, through a variety of markets and political channels. But to understand why we have the patterns of economic activity and environmental impact we do, it is essential to go behind these mechanisms to examine the underlying determinants of values and beliefs; of knowledge and technology; of market power or institutional influence. It is necessary to explain how beliefs are formed, values transmitted, community relationships with nature established. The evolution of technology in response to broad philosophical orientations as well as concrete market signals must be understood. And the distribution and accumulation of power to influence the market decisions or political actions which drive human activities and hence shape both their impact on and their response to global change must be analyzed.

It is to such explanation that a great deal of relevant research in a wide range of social sciences is addressed.

Culture and Values thus denotes the study of the preferences, perceptions, social norms, cultural artifacts, and ethical values that shape people's choices (economic, political, cultural, and social) affecting the natural environment – what is desired – and normatively, ethical reasoning evaluating these factors and their outcomes – what ought to be desired. The important research agenda involves what factors most strongly affect the kinds of behaviour with most significant impacts on environment, and how these factors change and interact.

Technology denotes the set of physical transformation possibilities available as instruments for the playing out of individual and collective choices – what is possible. Technology is determined by the present state of knowledge about people and the physical world, is embodied in a society's capital (including human and institutional capital, as well as physical), and is modified by research, innovation, education, and communication.

Economy denotes the study of aggregation by market mechanisms that translate individual economic choices into collective decisions as to what is produced, consumed, and disposed of. Governance denotes the study of other institutional mechanisms for translating individual into collective choice – legal systems, hierarchical organizations, co-operatives, elective politics, bureaucratic regulatory systems, and so on.

4. *A Framework for a Research Agenda*

Figure 3 does not show the four policy areas selected above, which can be thought of as cutting across all four of the research perspectives. The combination of four policy areas and four research perspectives can be represented by a four-by-four matrix, as shown in Figure 4. The rows represent policy areas, each lying in the jurisdiction of a government body, that are central to Canadian concerns with human-environment interactions. The concrete questions to which policy-makers need answers lie along these rows: should we subsidize agriculture, and if so, how; should we make major public investments in energy supply projects and if so, how and which ones; how should we use our available policy instruments to influence the location and structure of settlement and industry?

The columns identify the possible conceptual lenses for thinking about environmental policy questions; they identify the approaches, based on interest and disciplinary background and training, that researchers are most likely to take in studying questions of global change. Most, although by no means all, of the existing large body of relevant social research corresponds to the columns of this matrix. To match the existing body of research with the needs of policy-makers, part of what is needed is research that fills in particular cells of the matrix. But also needed is research that bridges gaps between cells in a given row, moving toward an integrated view of a policy area that balances considerations of technical possibility, cultural and value systems, and institutional mechanisms for collective decisions and management.

Figure 4
Identifying Characteristics of Existing or Proposed Research

Research Perspective / Policy Fields	Values	Institutions	Economy	Technology
Energy				
Agriculture/ Fisheries/Forests				
Ecological Resources (Air, Water, Soil)				
Settlements/ Migration				

The conclusions from this brief review thus can be summarized as follows:

1) The policy challenges posed by global change could be approached sectorally, by policy field. In that case, our limited consultations suggest that the priority fields, in which the most pressing national policy questions need to be addressed, are probably led by the four noted above – namely, Energy; Agriculture, Forestry, Fisheries and Wildlife; Air and Water; Urban and Industrial.

2) The social challenge of global change might alternatively be addressed by structural element or disciplinary orientation. In that case, the four broad topics offering the most fruitful organization for current research in Canada are those identified in this section – namely, values and culture; markets; collective or non-market institutions; and technology and resources.

3) But in either case, the most compelling requirement, in work to bring academic research to bear on pressing national policy concerns, is for research to interpret the independent specialized studies across the four topic areas and disciplinary orientations just mentioned; for this purpose, the interdisciplinary policy exercises proposed in this document offer the most promising vehicle.

5. *Survey of Existing Research*

Appendix A surveys the social science literature relevant to global environmental change. While the breadth of this subject requires that such a survey be highly selective, two particularly salient themes are evident in the recent literature.

First, research has moved progressively from examining one issue at a time toward several at once. There is increasing work on comprehensive studies of interacting resource, environmental, social, and economic phenomena. At the same time, researchers have grown increasingly sophisticated in their view of the spatial scale and time span of interacting social, economic, and environmental phenomena. This trend is evident in recent work on comprehensive inter-disciplinary regional case studies, in the developing field of reconstructing economic-environmental histories, and in the design of both analytic models of human-environmental systems and policy exercises to study interactive decision-making in complex uncertain situations.

Second, the economic literature on market failures associated with environmental and resource issues is now well developed; examination of these issues now most often raises questions that lie outside traditional economic study, in two areas. First, there are many occasions when people's behaviour seems not to exhibit the properties of individual rationality assumed by economic models; in these situations, it is necessary to examine the cultural and value systems that underlie individual and collective choice, which often have greater influence on the aggregate sustainability of behaviour patterns than narrowly-defined economic incentives. Second, there are many occasions when individually rational economic behaviour yields outcomes that are collectively

destructive; in these situations, the crucial questions concern the design of institutional arrangements for management and governance of natural and economic systems, to channel individuals' economic choices into directions more likely to yield sustainable outcomes.

B. Criteria for Future Research Priorities

If we accept this policy-oriented framework for research on the Social Challenge of Global Change, it then becomes relatively easy to identify several criteria to govern the selection of topics and the determination of priorities. These criteria include:

- that the research topic offer a reasonable expectation of yielding knowledge that will be useful to policy-makers having a responsibility to deal with current national problems;
- that the research focus on the phenomena that link the social, economic and cultural causes of global change to the perceived impacts of global change;
- that it be consistent with the efficient allocation of research effort internationally, by focusing on particular Canadian research needs or opportunities. A Canadian comparative research advantage could originate in any of several factors: that the unique history, geography, institutional structures, or role in world affairs of Canada make a particular research endeavour more urgent or more suitable for study in Canada than elsewhere; or that world-leading researchers work in Canada.

C. Themes for a Research Program

1. Institutions and Decision Processes

Humans, and the decisions they take, are a force with nature and principal agents of Earth change. Our economic and ecological systems have become totally interlocked in reality. In our institutions, however, they remain almost totally divorced. If society is to gain greater capacity to manage the human dimensions of global change, it must find ways to bridge this gap, and to integrate ecological considerations into central political and economic decisions.

The issues of global change and survival involve fundamental questions about power patterns and relationships: how they are now reflected in political, public, corporate and private institutional structures and decision-making processes; and whether and how they can be modified to ensure forms of development that are more sustainable.

The dangers posed by global change, and the need for alternative, sustainable, forms of development must become primary considerations in decisions on macroeconomic policy, trade and fiscal policy, science and technology, energy, agricultural, industrial and other sectoral policies. This calls into question current forms of responsibility and accountability in public and private institutions; it also raises major questions about the shape and political feasibility of alternative forms that are to be incorporated in actual institutional structures and decision-making processes.

Institutions capable of taking a sufficiently long and broad view, and of making their decisions stick, are strikingly absent on the national and international stage. An important theoretical question is that of commitment: what conditions enable individuals or nations to bind themselves to act together for the common welfare, and how can the practical duration of such a commitment be increased?

Accountability and Responsibility

How can corporate bodies and agencies of government (including CEOs, Ministers and similar individuals) be made directly responsible and fully accountable for ensuring that their policies, programs and budgets support development that is sustainable?

Similarly, how can corporations and governments be made responsible and accountable for the impacts of their economic and political decisions that reach beyond their own municipal, provincial or national jurisdictions, i.e. that affect the ecological capital of neighbouring municipalities, provinces, nations, or the global commons? How can they be made responsible and accountable for the impacts of their decisions on future generations?

What changes in traditional power patterns and relationships would this involve? Can such changes be achieved in the face of current societal values and dominant institutional cultures?

Within the public sector, how can these considerations be reflected in the structure and processes of departments, cabinet committees and similar bodies? What does this imply for existing forms of accountability, such as parliamentary committees, audit systems, and the role of ombudspersons?

Within the private sector, how can these considerations be reflected in laws and incentive systems (taxes, loans, depreciation allowances, leases, patents, regional development grants, etc.) that affect corporations, and in the structure and decision-making processes of corporations? What does this imply for the traditional goals of corporations, or for the responsibilities of boards of directors and their accountability to shareholders?

When the potential impact of decisions is particularly severe, what forms of public scrutiny should become mandatory? What does this imply for the roles and powers of extra-corporate and extra-parliamentary institutions (e.g. scientific bodies, standards-setting bodies such as accounting associations, and independent policy or research institutions), community organizations and nongovernmental organizations? What are

the implications for public participation in decision-making, and the right of access to information needed for informed public discussion and participation? Can these implications be reconciled with traditional notions of corporate and ministerial responsibility, or must these concepts be modified?

International negotiations on the environment: do the distinct characteristics of global environmental issues, expressed in terms of the internal and external distribution of costs and benefits, the nature of uncertainty about future costs, and principal-agent relations, give these issues a significantly different structure than the older issues on the international agenda, such as trade and security? If so, do these structural differences suggest different ways of crafting international organizations or negotiating fora? Alternatively, is the range of feasible tradeoffs within a strictly environmental negotiation so limited that progress can only be made through comprehensive negotiations involving trade and/or security as well? Do recent examples of international environmental negotiations offer insights into the roles taken by different nations or alternative negotiating structures?

International Issues and the Global Commons

The integration of ecological decisions into the legal and institutional structures and decision processes within countries has to be matched at the international level. Growth in economic activity, and energy and materials use means that direct physical linkages between the ecosystems of different countries, already considerable, will increase. Economic interactions through trade, finance, investment, culture and travel will also grow, further interlocking the world's economic, social and ecological systems. What does this imply for global change and for mandates, authority, structure and processes?

The need for management of the global commons (the oceans beyond the economic zone, the atmosphere, Antarctica and outer space) will also grow. How adequate are our international agreements and institutions for this task?

How well adapted are our international arrangements to deal with issues, such as global warming, that cut across many sectors (energy, forestry, agriculture, trade, debt, etc.) and that have widely differing impacts in different countries? Is a traditional negotiating forum too narrow to offer reasonable prospects of success? Given the impossibility of dealing with effects without considering sources, and the need for national and sectoral tradeoffs, what alternative forms of negotiation can be envisaged? What role can Canada play in advancing such developments?

The international legal framework: to what extent do existing international resource or environmental agreements (e.g. Stockholm declaration, Vienna convention and Montreal protocol on substances depleting the ozone layer, Law of the Sea, European Convention on Long-Range Transboundary Air Pollution) provide appropriate models for international action on the most pressing current problems? More importantly, what crucial features do they lack?

The Time-Frames for Decision-Making

The relationship between economic and ecological systems depends mainly on human decisions, and critically on the time-horizon of the decision-maker. If the horizon is short, decisions tend to enhance economic and political aspects at the expense of the ecological capital of the corporation or government involved. Agriculture and forestry provide obvious examples, but the need to assess implications and take decisions over longer time-frames is widespread. This is especially so when the decisions involve irreversibilities (e.g. ozone depletion), persistence (e.g. toxic chemicals), and future generations (e.g. the preceding examples, energy policy, global warming). What changes in value-systems, institutions, and decision-making processes are required to provide a more appropriate time-frame?

Within the private sector, it can be argued that recent advances in business information systems have converged with incentive and remuneration practices, decision processes, and traditional power relationships to shorten still further the time horizons of corporate decision-makers. In the public sector, advances in polling and opinion surveys have similarly reinforced the pressures of election cycles and political pressures to emphasize short-term decisions. How can such pressures be modified, so as to enable decisions to be assessed and taken within time-frames appropriate to the problems involved?

It is clear from the above that the *integration* of ecological considerations into public and private decision-making will generate policy choices that are inherently more complex and politically difficult than in the present situation, in which ecological considerations tend to be considered, economically, technologically, institutionally and politically, as an *add-on*. If society is to cope successfully with this change, it will require new and immense efforts to inform the public and to advise decision makers.

Such efforts will necessarily involve the scientific community, research and policy analysis institutes, private organizations, community groups and the media. If such bodies are to be actively involved, without constraining their individual independence, new forms of policy research and development are required. The 'policy exercises' that are a central element of the present proposal (Chapter II) are intended as such an innovative response to the need for a more integrated approach and a more appropriate time-frame.

2. *Economy-Environment Linkage: Sources of Global Change Rooted in Economic Incentive Systems and Decision Processes*

In addition to the institutional integration requirements addressed in theme 1 above, there is need to consider the problems of analytical or methodological integration to support the linking of environmental and economic considerations in economic behaviour and institutional decision processes. Although the academic literature on this topic is well developed at a theoretical level, corresponding empirical work is largely lacking, and the broad appreciation necessary for practical application in government or corporate

decision processes is almost entirely absent. There can be no doubt that, if societies in Canada and throughout the world are to respond effectively to the threats posed by accelerating global change, major alterations will be required to long-standing and well-established policies and practices that are at the heart of the linkage between economy and environment.

How can environmental imperatives be routinely recognized in a wide variety of situations, and incorporated into standard systems of analysis and decision-making? For example:

- Decisions on resource use are based almost universally on evaluations of costs and benefits that are effectively limited (through discount rates and other techniques) to very short-term factors. The legacies of such past decisions are now plainly evident in many of the problems we face today in Canada (e.g. sediments on the lake-bottoms of the Great Lakes that accumulate decades of toxic waste dumping in the lakes; similar toxic hazards from land-based dumps, including contamination of the groundwater from long-term leakage of such dumps). In some cases, direct and immediate health hazards generated by such short-term attitudes have led to better controls on present day emissions. However, the rapid onset of global change makes it clear that, apart from such immediate concerns, we are doing little more than attempting to solve the problems of the past, while we create much more serious crises for the next generation. How are the notions of trans-generational equity and spatial equity to be incorporated into economic decision-making?

- Although economists make no claim that Gross National Product is a comprehensive or adequate measure of either wealth or welfare, it has come into common use for exactly this purpose. A nation's 'progress' is measured over time by changes in GNP, and the nations of the world are grouped into categories of 'development' according to per capita GNP. Both these habits imply that a rising GNP is a measure of increasing wealth, development and well-being. Yet GNP measures the monetary value of resource flows, rather than the asset value of resource stocks, so that a country, or a region, may achieve a rapidly-rising GNP through economic activities that liquidate the natural resource base as quickly as possible. More generally, national accounts contain little or no record of the depletion of national resources. Resources that are not accounted for are apt to be wasted or managed inefficiently. How can widely-used macroeconomic indicators be improved so as to incorporate sustainable development criteria, enabling them to be used as indicators of the amount that can be consumed today without lowering consumption possibilities in the future?

- How can economic analysis be modified so as to recognize unquantifiable factors such as environmental quality as more than peripherals or marginal addenda? For example, it may be extremely difficult to incorporate the effects of pollution emissions from a smokestack into the evaluation of a proposed electricity generating station, especially when the nature of long-distance pollution transport and 'acid rain' is such that there can be no measurable link between the specific emission and subsequent ecological damage. The general connection between such emissions and such damage (or the effect of such fossil fuel emissions on global climate) is nevertheless well-documented.

– How can analysis and evaluation techniques be similarly modified to take account of anticipated irreversible effects, such as species extinctions, groundwater contamination, fossil fuel depletion, forest destruction or soil erosion, especially when these may become evident only after the (usually brief) lifetime over which a development project is normally evaluated? Because of lag times in natural systems (e.g. the 'greenhouse effect') many present activities may lead to effects that have become irreversible by the time that they become acute. It has, in fact, been suggested that irreversibility of environmental effects is the normal case; reversibility is relatively uncommon.[19]

It will be evident from these examples that much of the research proposed in this portion of the work plan involves the translation into empirical reality and policy applications of insights already identified in the theoretical literature relating to accounting and information systems (particularly in respect of resources or impacts presently unpriced), incentive systems, and decision processes within individual organizations (and indeed of individuals themselves).

Policy-oriented research on the relationship between structural change in the economy and global change is also vital. What is required is something analogous to the research and action on the link between energy and economic activity that occurred during the 1970s in response to the energy crises in that decade. Driven by OPEC and encouraged by the International Energy Agency, many industrialized countries took actions that effectively decoupled the intimate association between energy input and economic growth that had been characteristic for many decades. It can be demonstrated fairly readily that a reduction in the resource input of production will lead to a reduction in the amount of emissions and wastes, as well as to a reduction in the overall costs of production, and consequent increase in productivity and competitiveness. On the broad scale of national or regional economies, this is evident in the shift in industrial structure that is typical of post-industrialism; the higher the level of national wealth (even if defined inadequately by GNP or similar indices), the lower the environmental impact per increment of wealth tends to be.[20] Moreover, a reduction in the resource and environment content of national production can result in a significant improvement in international competitiveness, as the experience of Japan, Sweden and West Germany indicates.

This raises several questions for empirical research. What are the trends in energy, land, water, and resource efficiency generally in Canada? How do they compare with other nations? What are the relationships between resource and environmental efficiency and macroeconomic performance? How can incentive systems be modified, and new ones developed, to induce behaviourial change, leading to appropriate reductions in resource inputs? During the energy crisis, such changes were driven by dramatic increases in prevailing and anticipated energy prices, but relatively little attention has been paid to this question in other sectors.

3. *The Cultural and Ethical Roots of Economic/Environmental Behaviour*

In their report on the 1987 RSC workshop on 'Managing Global Change', Braybrooke and Paquet noted that the emergence of a consensus among natural scientists on the reality and character of global change

> does not mean that the global risks they point to will be perceived as such by the population. *Risk is a cultural concept:* existing institutions select problems and risks worth taking into account. The institutions doing the recognizing and the classifying may systematically disregard problems that would threaten values or deconstruct institutions.[21]

Given this critical importance of values, Braybrooke and Paquet expressed concern about the widespread 'silence' that existed in Canada in the social sciences, and also, more disturbingly, in the humanities in regard to global change. At the RSC workshop, it was argued that one of the first requirements was a model of man appropriate for the study of large-scale long-run phenomena such as global change. Such a model should provide

> . . . a realistic appraisal of the breadth of interests of human beings, of their passions, of their capacity for rational choice, and of their capacity for perverse or counter-intuitive behaviour.[22]

Lack of such understanding was seen by the workshop as a major reason for the critical gap between scientific concern and public understanding:

> The somewhat mechanistic manner in which the broad issues have been cast by many hurried experts might explain why they have failed to ignite any real interest in the population. Much mention was made of the need to understand better the link between psychology and public policy. In many ways, the lack of a satisfactory model of man may lie at the root of the apparent incapacity to mobilize the population on the subject of global change.[23]

In the year or more that has elapsed since the RSC workshop, the 'silence' on these issues has been broken more frequently. For example, among the research topics suggested by the humanities and social sciences research community during the present project are the following:

- Feminist Perspectives on the Ethic of Exploitation: the feminist view on the environment and resource exploitation examines man's violence against nature and the importance of managing the earth well for future generations. Can a feminist ethic enhance our present system of policy-making and thus improve our chances of moving towards sustainability?

- Native Value Systems and Environmental Exploitation: it is often said that native peoples' religious and value systems regarded the earth as sacred, and so succeeded in establishing a norm of husbandry in resource exploitation. Is there evidence that this is true, or is the crucial factor simply the small number of people?

- Wilderness, Wildlife and Fisheries: because of Canada's distinctive geography, geology, and climate, the significance of wilderness, wildlife, and both inland and coastal

fisheries is probably more important in the cultures and value systems of both indigenous and non-indigenous Canadians than is typical of other industrialized countries. How are these cultures and values threatened by global change, and what priority can be given to their protection?

- Cross-Cultural Studies of Environmental Ethics: is there any evidence that some national or ethnic groups' value systems are more effective than others in keeping a sufficiently broad and long view? The example of religions such as Islam and other Eastern philosophies has been cited in this connection, as have the practices of Japanese corporations. Might some of these cultures or value systems achieve greater regard for the future, and can they do so without sacrificing due regard for other contemporary groups?

- The Role of Communication and Symbol in Public Values: a platitude has it that 'in politics, the perception is the reality', but short-term public perceptions and the long-run factors that generate them sit in uneasy balance. North Americans' responses to African drought, and the response this past summer to the heat wave and drought, both show that compelling political forces can be created in the short-run to respond to problems whose origin and solution are both in long-term causes. What factors determine when a long-run problem can burst onto the short-run political agenda? Can decision mechanisms be crafted that channel this political will in the short-run towards addressing the long-run underlying problems?

IV. Conclusion

In brief, the literature survey, analysis, and consultations carried out during the brief period of this project lead to the following conclusions:

A. A program of policy research on 'The Social Challenge of Global Change' is of highest priority as a strategic theme. This theme should focus on the processes of social learning and individual decision-making that underlie and shape human interactions with the natural environment.

   On the basis of an extensive examination of existing literature and current work, this report has demonstrated the urgent and pressing need for such research; has identified some key research issues; and has confirmed the capacity of existing researchers and research centres in Canada to contribute fruitfully and constructively to the examination of these key research issues.

B. The program should be structured so as to achieve some significant financial leverage, and to tease out some additional funding. This proposal suggests three principal avenues by which this objective can be pursued: through an element of matching funding; through the orientation of proposed departmental or industrial financing towards problems of particular priority in this context; and through special efforts to draw out the particular implications for this program of larger research efforts under way in other domains.

C. This program should be focused on the dissemination of research results, and the animation of a process of application and implementation of the research: focused, that is, on a social learning approach within a policy research environment. The

emphasis, in other words, must be on the translation from underlying research cast in traditional analytic perspectives to overarching consultation processes structured around quite different policy perspectives, and shaped within a different policy agenda.

D. A process of research, synthesis, commentary, and review in the context of a program of policy exercises can be constructed to meet this need to bridge from the world of research to the world of collective action, and such a process is outlined in the proposal. About one-third of the direct SSHRC financing for the proposed strategic theme should be allocated to this purpose.

E. As a body charged expressly with responsibility not only to undertake policy research and dissemination, but also to promote an active public debate and the broadest possible participation in such debate, IRPP is well placed to carry out this last element of the overall program. Through its Members, IRPP offers a broadly representative national forum. It is particularly well placed to organize a prestigious Advisory Panel to review the direction and results of the program; to advise on priorities for the program, and to carry its results into public debate and policy action. Through its associations with university researchers from coast to coast, the Institute is also able to engage outstanding researchers to participate in a coordinated program of research on the specific topics identified here.

This proposal for applied policy research thus differs from more traditional research endeavours in its relatively greater emphasis on synthesising and using the information available from a network of research activities, bringing it effectively into social and governmental discussion processes, rather than on the development of new intellectual and analytical constructs. But it must be emphasized that the proposal is founded essentially on the traditional research activities supported by SSHRC; it embraces new theoretical and analytical work on the dynamics of negotiation and consultation; on the influences of social interactions in processes of policy formation; on mechanisms for resource management within various possible structures of property rights; on philosophical, ethical and cultural considerations underlying resource allocation decisions; but above all on the institutions for using such knowledge to inform social learning and social decisions in support of sustainable development.

Policy research is research for a purpose. In the present proposal, this Institute has outlined a program which we are convinced will assist SSHRC to ensure that Canada's impressive research capabilities in the human sciences are more effectively harnessed in addressing the most pressing of contemporary national policy challenges.

Notes

1. Social Sciences and Humanities Research Council of Canada, *SSHRC: Focus on Strategics*, Ottawa, 1988.
2. *Idem*.
3. Royal Society of Canada, *The Canadian Global Change Program/Le Programme Canadien de la Transformation du Globe*, Ottawa, 1988.
4. *The Human Dimensions of Global Change: An International Programme on Human Interactions with the Earth*, Toronto, 1988, unpublished.
5. World Commission on Environment and Development, *Our Common Future*, Oxford University Press, New York, 1987.
6. *Ibid.*, pp 313-314.
7. National Task Force on Environment and Economy, *Report*, Canadian Council of Resource and Environment Ministers (CCREM), Ottawa, 1987.
8. Royal Society of Canada, *The Canadian Global Change Program/Le Programme Canadien de la Transformation du Globe*, (version submitted to the National Sciences and Engineering Research Council), 1988, p. 2.
9. *Op.cit.* (note 5), p. 27.
10. See *Our Common Future, loc. cit.*
11. *Idem*.
12. *The Human Dimensions of Global Change: An International Programme on Human Interactions with the Earth*, IFIAS - ISSC - UNU, Toronto, October 1988.
13. Braybrooke, David & Gilles Paquet, 'Human Dimensions of Global Change: The Challenge to the Humanities and the Social Sciences', *Transactions of the Royal Society of Canada*, 5,2, 1987, pp 271-291.
14. The ideas expressed in this and the preceding paragraphs owe much to a paper presented by Peter Timmerman (Institute of Environmental Studies, University of Toronto) to the First United States-Canada Symposium on the Impacts of Climate Change on the Great Lakes Basin, Chicago, 27-29 September 1988.
15. *Focus on Strategics, loc.cit.* (note 1), Annex I.
16. Interim Report of SSHRC Task Force on Priorities, January 1988.
17. Toth, Ferenc L., *Systems Methods for Environmental Management*, Biosphere Project, International Institute for Applied Systems Analysis (IIASA), Laxenburg, Austria. See also *Policy Exercises: Procedures and Implementation*, by the same author.
18. It may be necessary to emphasize that this language of systems theory, or 'systems perspective', is adopted for expository purposes; it is not intended to suggest any fully causal structure, or fully specified 'social dynamics', nor to overlook the fact that the ways in which people interact in the games they play may alter the systems and rules of the games themselves. It should also be noted that neither the natural system nor the human system is entirely closed.

19. This argument is developed more fully in an unpublished paper entitled 'Neoclassical Economics and Principles of Sustainable Development', prepared for the Brundtland Commission by Robert Goodland and George Ledec, The World Bank, Washington, D.C.

20. 'Ecological Modernization of Industrial Society', paper prepared for an environmental conference in Milan, Italy, 24-26 March 1988, by Udo E. Simonis (Science Center, Berlin).

21. Braybrooke & Paquet, *loc. cit.* (note 13), p.274.

22. *Ibid.* p 283.

23. *Ibid.* p. 284.

Appendix:

Literature Survey and Analysis

Part 1: Introductory Comments

1. The literature relevant to the subject of global change is already vast, both in its historic span and in its disciplinary coverage. The range of scholarly work relevant to possible social responses to the challenges posed by accelerating global change is even more extensive. Consequently, any survey such as this must be highly selective, seeking those lines of research from a variety of disciplines most relevant to global environmental change, and endeavoring to draw out only the most seminal themes from past work to illuminate present research priorities.

2. There exists less a separate Canadian literature, than a strong history of Canadian contributions integrated within an international literature. Consequently, in this historical literature review, themes will be drawn from the international literature, and note made of particularly significant Canadian contributions.

3. At the broadest level, the Social Challenge of Global Change can include three related research themes:

a) the social impact of global change: what elements of global environmental change have the strongest impact on society; how can social impacts be measured broadly, incorporating cultural, ethical, and political effects as well as economic effects; what factors mitigate impacts, and how do they interact and evolve?

b) the social response to global change: what are the economic, political, social, cultural, and behavioral phenomena that shape human activity in response to such impacts; how do these factors interact and evolve, taking into account these behavioural adjustments; what can be done, and by whom, to mitigate the impacts of global change on

human welfare, and to modify the decision-making systems, cultural norms, and other forces that underly human activities affecting global change?

c) the social origins or causes of global change: what are the economic, political, social, cultural, ethical and behavioural phenomena that shape, in particular, human patterns of resource exploitation and environmental impact; how do these underlying factors interact and evolve; how can the consequent impacts be measured and monitored; taking into account these underlying beliefs and behaviours, what can be done, and by whom, to lessen the impacts of human activity on the environment?

4. Prior to the last decade relatively little social science research was *explicitly* on global change, and what little there was often mingled social commentary, newly-emerging knowledge in the natural sciences, and current political issues. Examples include George Perkins Marsh's *Man and Nature*, which gave voice to the 19th Century Conservation movement; Rachel Carson's *Silent Spring*, which galvanized the 1960s environmental movement; and widespread speculation over catastrophic futures that appeared in the early 1970s, prompted by reactions to global modelling exercises such as *The Limits to Growth*.

5. A far larger body of social science literature is *implicitly* relevant to Global Change – not directly motivated by considerations of environmental sustainability, but closely related to one of the three themes stated above. This category includes, for example, anthropological literature on the influence of cultural norms and value systems on the resource exploitation practices of societies; psychological literature on attitudes toward and perceptions of risk, and on how people weigh the interests of future generations; the study of how communication and symbols affect attitudes toward growth, development, and the environment; and a vast quantity of work in geography, sociology, government, law, history, and economics.

Part 2: The Long-Run Heritage of Sustainability

6. If one looks hard enough, the roots of the notion of sustainability are ancient indeed. They go back to biblical notions of stewardship, and to a Utopian literature dating at least from Classical Greece, through Augustine and Thomas More.

7. Explicit recognition of the relations between human activities and the limits of the natural system can be found in the enlightenment philosophers and the classical economists. Condorcet argued for limitless human perfectibility, but expressed his vision so ambiguously that it could represent either material or spiritual progress.[1] Malthus's seminal work first stated the conflict between tight global constraints and intrinsically exponential processes of human growth.[2] The classical economists mostly held the view that the generation and accumulation of material wealth was only a temporary problem, so their description of human activity applied only to a transitional period in human progress. This view was best stated by Mill:

> "The increase in wealth is not boundless: at the end of what is termed the progressive state lies the stationary state: all progress in wealth is but a postponement of this .... I cannot regard the stationary state of capital and wealth with the unaffected aversion so generally manifested towards it .... A stationary condition of capital and population implies no stationary state of human improvement. There would be as much scope as ever for all kinds of mental culture, and moral and social progress ... when minds cease to be engrossed by the art of getting on."[3]

8. Later work in political economy largely lost touch with these early insights. The classical formulations of Walras, Marshall and Hicks, and modern neo-classical theory, are principally based on the twin assumptions of insatiable material wants and limitless material inputs. The assumption of insatiability was periodically questioned – Veblen presented a *reductio ad absurdum* of the assumption of insatiability with his sardonic description of conspicuous consumption, the social phenomenon that allows desire for consumption to inflate beyond any physical foundation,[4] and Keynes' notion of the "euthanasia of the rentier" also reflected the view that capital growth would eventually cease.[5] But explicit consideration of natural constraints on aggregate economic activity was largely absent from this literature.

9. Outside economics, the early 20th Century was marked by the emergence of grand integrating theories, conceptual schemes that regarded natural systems and the webs of knowledge and values determining human exploitation as a single, integrated whole. The Russian geologist Vernadsky formulated the notion of the Biosphere,[6] and the French paleontologist Teilhard de Chardin that of the Noosphere,[7] each reflecting the intimate coupling of human and natural processes in shaping the evolution of the earth. These notions, though presented less specifically and with slight differences of emphasis, anticipated Lovelock's Gaia hypothesis of the 1970.[8] These integrating concepts reintroduce linkages between human and natural systems, but do not express the linkages explicitly as constraints.

10. The possibility of natural constraints on economic growth first re-entered public discourse after World War II. Concern was sharpest in the U.S., and was focused on shortages of physical raw materials, especially non-ferrous metals. The issue remained prominent for about ten years, prompted several high-level official and academic studies,[9] and receded from view for two reasons: most studies argued from historical patterns of declining real extraction cost, and from current evidence of substitutability, that materials shortages would not limit economic growth;[10] and public and political attention shifted to air and water pollution.

11. In the 1960s, the new issues of local air and water pollution spawned the environmental movement and a new collection of social criticism focusing on human-induced degradation of natural systems. The fountainhead of the movement was Rachel Carson's *Silent Spring*,[11] which described the consequences of DDT spraying in the forests of New Brunswick. The movement coincided with the public emergence of the discipline of ecology, and made extensive use of analogies between ecological concepts and human activity. In particular, the concept of carrying capacity seemed a trump card in the debate over human population.[12] More recently, though, the concept has seemed of limited use for a sophisticated debate on sustainability of human systems, because it begs two

fundamental questions: whether technical progress can continually increase the feasible human population; and whether considerations of quality of life, social stability, or justice dictate a preferred human population well below the physical carrying capacity at any time.[13]

12. The early 1970s saw the beginning of the global modelling movement, announced with the publication of *The Limits to Growth*,[14] commissioned by the Club of Rome and undertaken at MIT. This work represented an expansion of view, to global scale and to simultaneous consideration of pollution, resource, and food constraints, but no adaptive feedbacks were incorporated into the models. By assuming exponential growth in human numbers and activities, pressing against fixed resource constraints and unmitigated by technological change, economic adjustment, or value change, the modelers projected catastrophe and re-opened the debate on the human prospect that has proceeded since Malthus, Godwin, and Condorcet. Their work spawned an active and combatitive literature[15] that finally suggested that the principal disagreements between modelers reflected different assumptions so basic – the rate of decline in energy and materials inputs per unit of output, for example – that models did not help to illuminate them. Even the central assumption of exponential human population growth remains open to question. Deevey,[16] for example has argued that in the long-run, human population shows long periods of stability punctuated by short intervals of exponential growth to a new equilibrium following major technical or social innovations.

13. The subsequent world modelling literature has became progressively more complex, with regionally disaggregated models[17] and progressively greater separation of sectors.[18] Barney et al. examined the implications of these models for Canada[19] and drew conclusions of guarded optimism. Dobell and Kennedy summarized the field in the context of comprehensive economic models.[20]

14. The debate over the possibility of continued growth sparked by the world modelling controversy prompted a re-opening of the same debate within economics, with the emergence of the "steady-state economics" literature examining the behaviour of closed economic systems with resource, free energy, or entropy constraints. Principal figures in the field included Boulding, Georgescu-Roegen, Daly, and Ophuls.[21] While differing in emphasis, these writers shared two major views: the empirical one that due to immutable thermodynamic constraints, growth in the material scale of economic activity must eventually cease; and the normative one that this end to material expansion will more likely advance than retard human welfare. In this sense, they echo Mill's sentiments above; unlike Mill, they assert that the end of growth is near at hand.

15. Others dissented. Simon and Kahn disputed the first assertion, arguing that technological progress in resource discovery, extraction, and substitution would render physical growth essentially limitless.[22] Olson and Landsberg disputed the second, arguing that the end of physical growth would inevitably focus political dissent on the division of a fixed pie, and that the resultant battles would be bitter.[23] Kahn accepted both premises but disputed the timing, arguing that material growth would come to an end, but not for roughly 200 years, and that we are presently at the inflection point of the intervening logistic curve – the point of most rapid growth.[24] It is tempting to speculate that, in Kahn's view, the time to steady-state might advance as time passes. The debate

over steady-state economics has continued into the 1980s, but remains somewhat isolated from mainstream academic economics.[25]

16. Within mainstream academic economics, though, several areas of work continue to address questions relevant to global limits. An extensive literature has developed since mid-century on the exploitation of natural resources, both exhaustible and renewable. The analysis is typically at micro rather than macro scale. Hotelling led early work in the field,[26] with his investigation of the optimal rate of depletion of an exhaustible resource such as a mine. Related results in renewable resources are also consistent with treating resources as capital assets like any other, and suggest a basic model of transforming an initial endowment of natural resources into an infinitely renewable stock of produced physical capital.

17. From early work on market failure developed the literature on economics of the environment, which considers environmental effects as external costs causing departures from market optimality, and examines policy solutions that internalize the externality – corrective taxes, permits, or regulatory standards.[27] Coase's work suggested that under certain restrictive conditions, pollution would not cause departures from allocative optimality, but would simply redistribute wealth from the victims to the polluter.[28]

18. There has been sharp controversy over the assumptions and the policy conclusions of these lines of research. Colin Clark pointed out that if resources are treated like any other capital asset, under certain conditions it would be optimal for the owner of a fishery to drive it to extinction.[29] This possibility of permanent (possibly sudden) resource degradation is assumed away in the standard economic formulation, but may be the most common situation in the real world.[30] The substitutability between natural and created resources also remains the subject of sharp academic and political controversy.[31]

19. Work in resource economics has also shown the fundamental importance of the institutional arrangements by which a resource is managed, and the manner of allocating property rights.[32] An early result was that a common-property resource is always overexploited; subsequent work has focused on attempts to find management institutions and policies that duplicate the optimality achieved, at least under some conditions, by sole ownership. In particular, work by David Feeny has been directed toward exploration of a variety of community structures or social mechanisms which might support efficient collective management of open-access resources, essentially by controlling entry to, and rates of, resource exploitation. As Feeny emphasises, such mechanisms may be traditional or informal, falling between the plan cases of full private property and state regulation explored by Hardin. (See "The Demand for and Supply of Institutional Arrangements" in Ostrom, Feeny, and Picht *Rethinking Institutional Analysis and Development*, cited in footnote 7.2.)

20. In public economics, the discipline of Benefit-Cost Analysis has been developed to address social decisions that cannot be guided directly by markets.[33] The crucial questions of the field include how to assign values to non-marketed environmental and resource amenities,[34] how society should trade off present against future interests[35] and how to incorporate the possibility of irreversible effects into social decision rules.[36] The

problems of trading off present against future interests become even more difficult when the time span is long enough that it concerns the interests of generations yet unborn.[37]

21. To clarify these matters, it is necessary to move behind simple assumptions of how people form values and make decisions, and ask how they trade off future against present interests, weigh others' interests against their own, perceive the boundaries of the groups with whom they share common interests, and view their community's relation to the natural environment. To investigate these questions, active literatures have developed in how people perceive their environment and how they assess environmental risks;[38] in how attitudes toward the environment are shaped by culture and evolve through history;[39] in how conflicts over environmental issues align with traditional dimensions of political conflict over distribution and values;[40] and in how legal principles can best reflect changing notions of environmental value and the conflicts among people that they engender.[41]

Part 3: Areas of Current Active Research

22. Recent work on global change and sustainable development has been characterized by several themes: first, there has been a series of landmark works intended to integrate broad streams of research and move the environment/development questions into the policy arena. The most prominent recent examples have been the World Conservation Strategy,[42] and the report of the World Commission on Environment and Development.[43] These represent both research efforts and policy efforts, and have been associated with formal organizational review processes leading to further work.[44]

23. In addition to these high-profile, official projects, there have been several ambitious inter-disciplinary research exercises under academic auspices. Examples include the IIASA project Sustainable Development of the Biosphere;[45] the 1987 Dahlem Conference on Resources and World Development;[46] the U.S. Social Sciences Research Council report on Forecasting in the Natural and Social Sciences;[47] and the 1987 Clark University symposium, "The Earth as Transformed by Human Action".[48]

24. Among the ongoing research work with a more narrow disciplinary focus, there are several salient research themes. **Defining sustainability** is an essential task because of the term's widespread and often inconsistent use in policy debates; several efforts are underway.[49] Closely related are efforts to broaden the definition of economic well-being to embrace non-marketed goods, distribution, and concern for the future,[50] and attempts to include natural resource and environmental measures in national accounts.[51] A particularly difficult problem in defining sustainability internationally is assessing the implications for sustainability of the resource depletion or pollution embodied in trade flows.[52] It remains clear, however, that a broad concept of sustainability, embracing political institutions, social relationships, and economic justice as well as renewable and exhaustible resources will be essential.

25. **Adaptation, Resilience, and Surprise:** In contrast to the early view of ecosystems as precariously balanced at fragile equilibria, Holling first developed the notion of ecosystem resilience and stability.[53] This work has provided a powerful organizing concept for research in techniques for management of natural systems,[54] and for thinking about complex dynamic systems with both human and natural components.[55]

26. **Environmental ethics:** There is a thriving body of research on the ethical foundations of decision-making affecting environment and development. In part this consists of ethical critique of the decision methods advocated by economists, such as Benefit-Cost Analysis;[56] in part it consists of attempts to broaden the range of ethical discourse beyond the point where the environment simply represents a vehicle for mediating ethical obligations among human beings, to vest ethical standing either in other living things or in whole ecosystems.[57] More general, the academic journal *The Trumpeter*, published at the University of Victoria with Professor Alan Drengson as editor, offers one Canadian vehicle for continuing dissemination of scholarly work on philosophical foundations underlying such environmental issues. The term "ecosophy" has been suggested by Professor Arne Naess to cover this field of environmental philosophy.

27. There are several active lines of research in the influence of **Culture and Values** on people's behaviour toward the environment. Some examine the roots of present behaviour and policy in our western cultural heritage,[58] and the role of different individuals' value systems in environmental disputes;[59] some consider how other culture and value systems may engender different environmental behaviour, and investigate how modern environmental movements have drawn on other cultural heritages.[60] Two particularly promising lines of research are on the relationship between value systems and resource management in aboriginal or native societies,[61] and the implications of feminist work on values and gender.[62]

28. With respect to the first line of development, it has been argued, for example, that the Iroquois Nations possessed a constitution based on the principle of government "of the people, by the people, for the people and **for generations yet unborn**" (emphasis added). This concern is expressed in the words of an Indian leader known as the Peacemaker, the founder of the Iroquois Confederacy, who is quoted as saying "Think not forever of yourselves, o chiefs, nor of your own generation. Think of continuing generations of our families, think of our grandchildren and of those yet unborn, whose faces are coming from beneath the ground."[63] In adopting a constitutional structure based on this model, with which they were thoroughly familiar, the framers of the American constitution unfortunately opted, it appears, for a structure of property rights leaving little room for the fourth, and key, element.

29. The principle of stewardship underlying the special relationship with the land which is said to guide native peoples in Southern Canada and the Inuit peoples in the North, reflects this same emphasis on future generations. As Osberg points out, the addition of terminal conditions of this sort would force an approach to the valuation of

environmental assets quite different from that in the usual models of economic growth or cost-benefit analysis.[64]

30. The second promising line of research has been the work undertaken on values and gender. This area of research may be broken down into two sections: gender and development; and feminist work on values and the environment, also known as eco-feminism. Theories of **gender and development** began with work in the 1970's by Esther Boserup who examined the sexual division of labour in developing nations.[65] Boserup's study was the catalyst for a great deal of work on gender and development theory. This work has focussed primarily on the political economy of women, and attempts to enhance current development theories by taking into account feminist theory.[66]

31. Gender and development research has prompted a great deal of emphasis on women in national policy-making, and gender has become the focus of many national and international organizations. The Canadian International Development Organization (CIDA) has held women in development as a priority since 1984.[67] The Indian organization Development Alternatives for Women in a New Era (DAWN) has been one of the most influential international development organizations because it explores global change from the perspective of Third World women, and offers long-term policy proposals, many of which are closely related to sustainable development.[68] Two of the best-known Third World women's environmental projects are the Women's Chipco movement in India, in which over 35,000 women are planting trees, and the Green Belt movement in Kenya, whose goal is also to save trees.

32. Recent feminist work on women's ecological values has been named **eco-feminism**. This theory found root when feminist academics began to develop interdisciplinary analytical tools which had a global perspective.[69] By way of this cross-disciplinary approach, many feminist writers have turned to an analysis of value systems: the contrast between the way in which men manage the environment, and women's attitudes towards the environment.[70] This has led logically to the study of women's values and attitudes towards the earth, and the way in which women manage resources. Eco-feminism proposes that women are closer to the earth; that to them, the earth is sacred; that they consider future generations and thus have a long-term attitude towards environmental management; and that women are more practical in their ecological philosophy.[71] Feminist theories, both in terms of gender and development theory and eco-feminism, thus offer policy-makers alternative approaches to coping with global change and the notion of sustainability.

33. Research on **institutional models for sustainable resource management** embraces several active lines. There is still an active literature on institutional solutions to common-property resource problems.[72] Other lines of work include the relation between division of powers in a federal system and the spatial scale of environmental phenomena;[73] co-operatives and the design of institutions to facilitate co-operation,[74] structures to support citizen participation in decision-making,[75] and the application of existing legal and diplomatic institutions to address international environmental problems.[76]

34. Current research on **Policy exercises and gaming** grew in part from earlier military work on War Games. The goal is the same: to study interactive decisions in complex situations, in which participants may have different perceptions, interests, and values.[77] A particularly interesting form is the writing of "future histories" to investigate ranges of plausible scenarios outside those normally considered.[78]

35. Finally, there is a thriving body of current research on comprehensive inter-disciplinary studies at regional scale. A particularly interesting example for integrated regional studies is the Great Lakes, because of the insights it offers into rehabilitation of degraded ecosystems.[79] Another approach of great promise is the reconstruction of regional environmental histories.[80]

Part 4: Current Institutional Research Projects

36. At present, there are several projects underway internationally to develop a social science research agenda to address global environmental change. A number of these projects have published statements of their proposed research focus. Their proposed major areas of research are summarized here.

37. The International Federation of Institutes of Advanced Study (IFIAS) is developing a program entitled "The Human Response to Global Change".[81] This proposed international program of Social Science research on Global Change would parallel the Natural Science effort proceeding under IGBP. The proposal document suggests five principal research themes: Global risk assessment; Analysis of complex systems; Needs of the most vulnerable; Environmental History; and Data Requirements.

38. In the United States, the National Research Council (the American participant in IGBP) has struck a "Human Response" Committee as one of its four area committees. The committee's draft report proposes five research areas: Population, development, and land use change; "Industrial Metabolism", the technological sources of global change; Integrated risk assessments for global change; Making research on global change more useful for the management of sustainable development; and Documenting the human dimensions of global change.[82]

39. The May 1988 Chinese-U.S. Workshop on the human dimensions of global environmental change[83] articulated three research themes: the Social Dimensions of Resource Use, including studies of demographics and migration, the determinants and impacts of long-term changes in land and water use, and elaborating environmental benefit-cost analysis; the Assessment and Perception of Environmental Change, including risk assessment, perception and knowledge, attitudes, and behaviour; and the Impact of Institutional Mechanisms on the Environment, including within-country and across-country comparative studies of the determinants and effectiveness of institutions for environmental management.

40. The U.S. Social Science Research Council 84 has proposed a research program to consist of four sub-projects: The social forces provoking earth transformation (demography, technology, rising human productivity, rising expectations, and worldwide commercial interactions); Social Feedback and Response (impacts of institutions, political systems, shared values); Vulnerability and Resilience of Affected Populations; and Monitoring Systems and Data Bases.

41. In December 1987, a workshop was held at Ann Arbor on an International Social Science Research Program on Global Change.[85] The workshop's report stated that the social science agenda should follow the issue agenda that the natural scientists have set, and articulated four broad areas of research: demography; surveys of human attitudes and behaviour; industrial metabolism; and human response and control mechanisms.

42. The striking characteristic of these institutional research agendas is that they all state essentially the same set of research themes: institutions, demography and land use, values and culture, and technology; most also emphasize the need for more extensive data collection. This unanimity suggests that the most fruitful research opportunities will lie within these areas.

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